Human System Integration: Challenges and Opportunities

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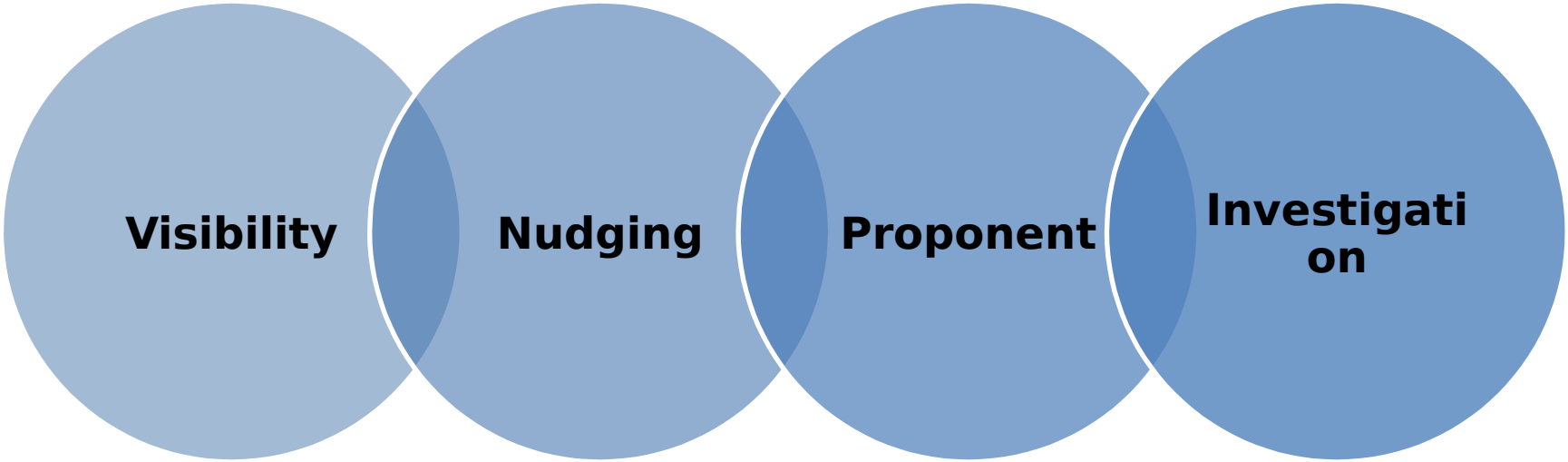
Improving HSI Practice



Leverage Points for Long Term Change

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Human Systems Integration

- **Human System Integration critical for ensuring the systems we procure are operable and maintainable**
  - **Significant impact on operations costs, operational errors, accidents, ability to perform mission**
    - **Ex. 80% of aircraft accidents attributed to human error – mostly design induced**
  - **Significant impact on maintenance, training & personnel costs**
- **History**
  - **1940-1950 – HSI is born in USAF operations**
  - **2004 – SAB identified significant USAF Human Systems Integration deficits**
  - **2005 – AF HSI Office established under AF/CV**
  - **2008 – 711th Human Performance Wing established**
  - **2011 – 711th BRACed to AFRL – Dayton**
- **Currently**
  - **AFHSIO & 711th have established a comprehensive program for HSI**
    - **Guidelines, toolkits, requirements documents**
    - **HSI training in Defense Acquisition University for contracting officers and program managers**
    - **Working to institutionalize HSI - responsibilities, forcing functions, tools, training**
  - **Largely underfunded**
    - **27 FTEs**
    - **In 3 of 47 SPOs, 5 MAJCOMS**
  - **Few programs aware of hidden HSI system deficiencies**

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Gap 1: Decision Makers do not perceive there is a problem

- **Inability to distinguish good vs. poor human interfaces**
- **Effects on human performance are invisible to them or explained away as something else**
- **“Users looked at it”**

Human Preference
≠
Human Performance

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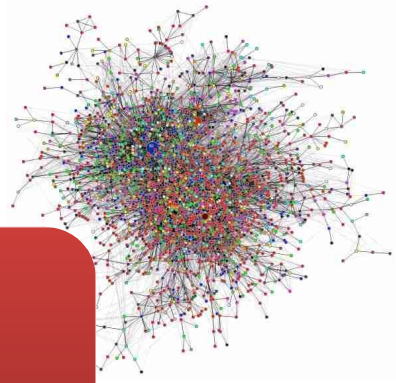
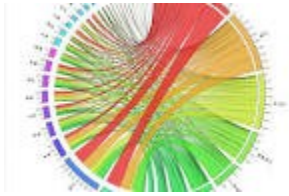
Gap 2: Poor understanding of what supporting the user means

- Focus on "new" UI technologies or concepts, without regard to how it impacts actual user needs or perf e





Cool ≠ Effective

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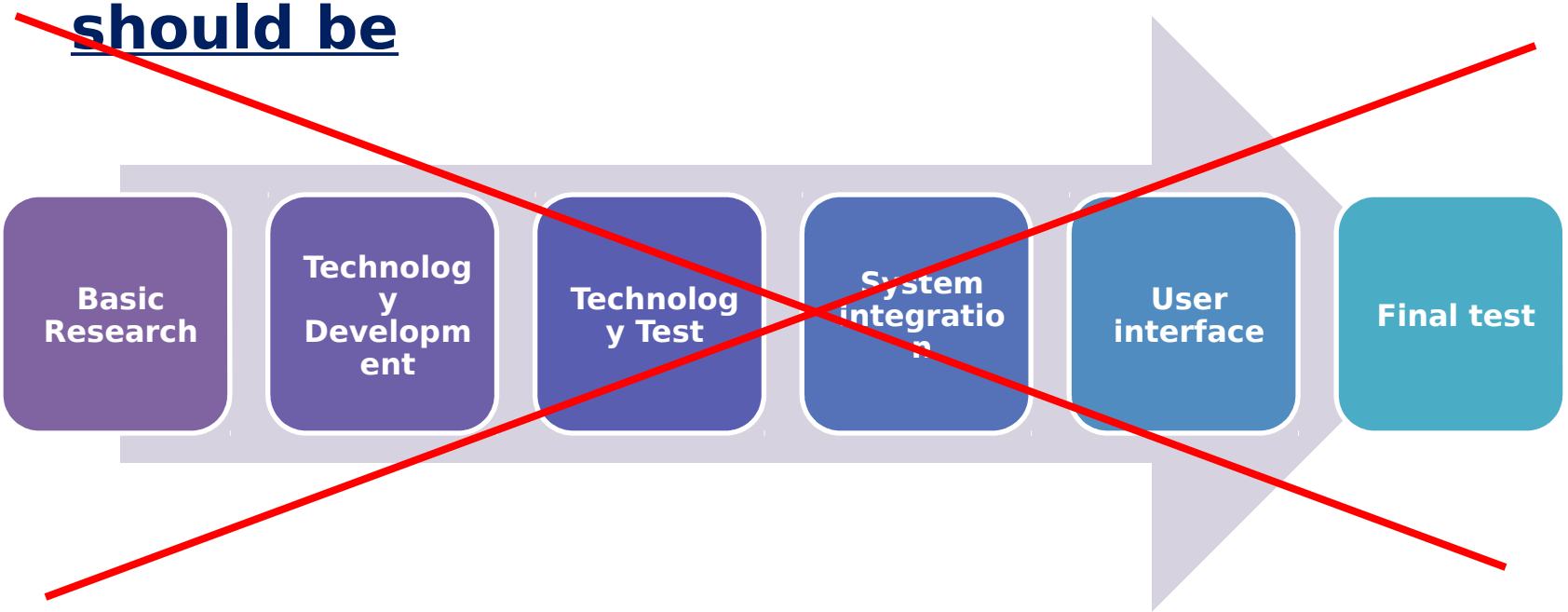
Gap 3: HF Too Late in Process

- **Decision makers sincerely believe the human interface <u>can</u> be done at the end and <u>should be</u>**



- **Removes the ability to effect the fundamental functionality and usability of the interface and usually the ability to make more than surface changes**

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Gap 4: HF practitioners do not communicate at the right level

- **Process/detail overload**
  - **What time it is vs how to build the watch**
- **Decision makers want to know**
  - **Will this work?**
  - **Has the needed development work been done?**

Complex ideas

Simple Constructs

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Gap 5: The Growth of DYI Systems

- **HSI programs in the DOD largely centered around the procurement process**
  - **Requirements that can be put into contracts and monitored for compliance**
- **Increasing numbers of technologies are being developed in house**
  - **Software**
  - **Additive manufacturing**

Need Easy to Use Human Factors Guides for programs within DoD

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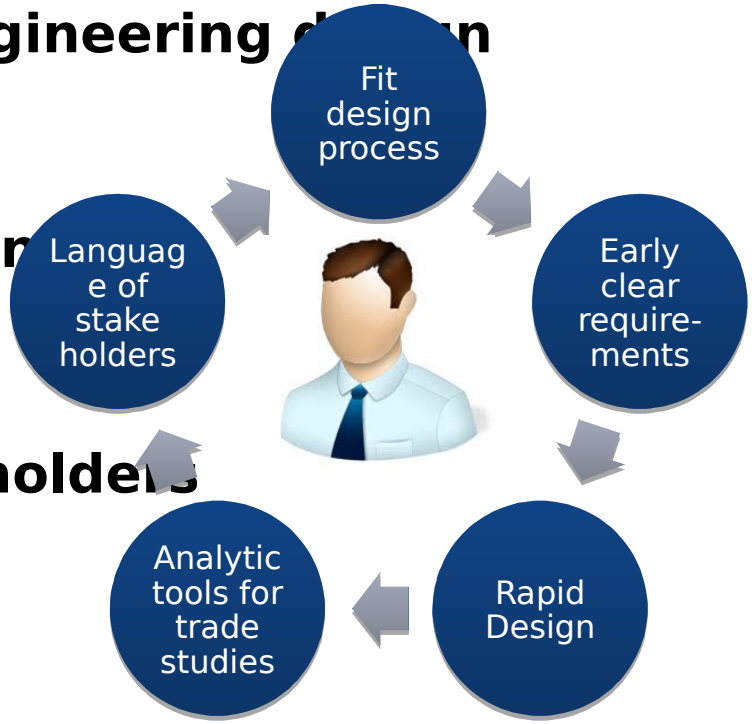
Physician – Heal Thyself

- **To improve acceptance of HSI - Follow our own advice**
  - **Make Human Factors & Ergonomics Products User Centered**
    - **Fit our activities within the constraints and requirements of the engineering design process**
      - **Fast and early**
    - **Provide analytic tools and models to support**
    - **Communicate in the language of the stakeholders**



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The Value Proposition Challenge

- **Decision Makers are attracted to tangible things that they believe will provide new mission capabilities or solve existing mission deficiencies**
  - **Intangibility Challenge**
  - **Process vs Product**
- **While HSI efforts often can show real improvements in human performance (workload/SA/error), these are generally not translated into mission performance metrics that decision makers grapple with**
  - **SWAP ✉ Mission endurance/capability**

HSI Opportunity

- **Cost as a major system driver**
  - **Operations costs**
  - **Maintenance costs**
  - **Training costs**
- **HSI can directly drive down life cycle costs of system**
  - **Must translate human performance metrics into measurable life cycle costs to show ROI**
    - **Reduced manning costs**
    - **Reduced training costs**
    - **Reduced accident rates (cost of systems, downtime, medical costs, …)**

0% reduction in time x 41,600 man-hours/year x $66.46/hour = $553K/year savi
Implementation cost of $500K = 110 % Annual ROI
or $2.26 M savings over 5 years

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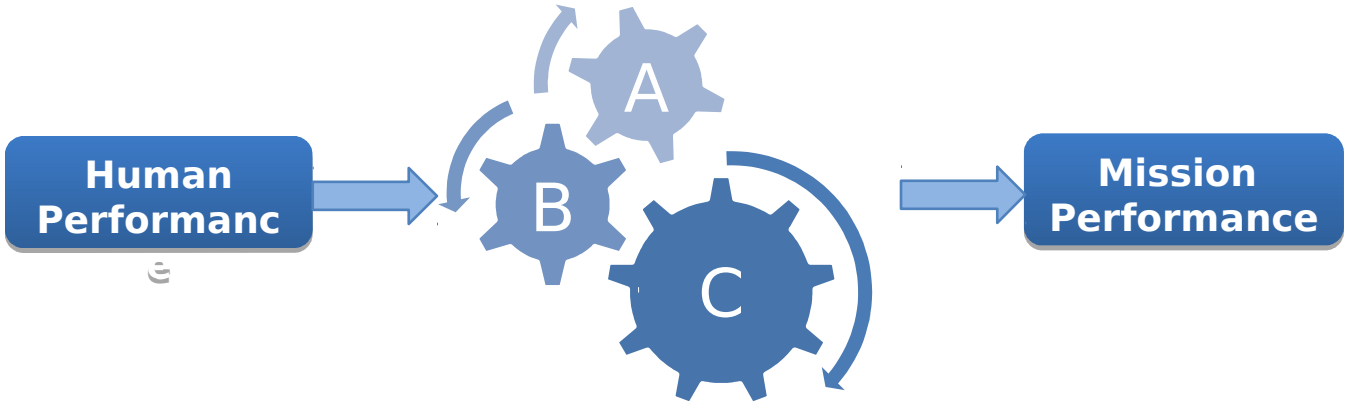
Determine Mission Value in Design Tradeoffs

- **What impact will buying the larger display have on mission performance?**
  - **Costs more, weighs more, takes up more space**
- **What impact will this software design have on mission performance?**
  - **Value not apparent**



Human Performance Impact Model

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System Requirements

- **Inadequate definition and detail**
  - **Contractors cannot or will not derive or design to meet operational needs with out clear requirements to do so**
    - **Creates systems that do not meet needs, are difficult to operate, and require extensive after market modifications**
  - **Gap in going from operational needs to detailed system specifications**
    - **BOGSATS generally inadequate to develop detailed needs**
    - **Cadre of personnel skilled at technical requirements writing lost in acquisition reform**
  - **Creates requirements churn**
- **Often missing Human System Integration (HSI)**
  - **Creates low usability, high operational costs, high maintenance costs, high accident rates**
- **Platform-centric**
  - **No emphasis on standardization, modularity**
  - **Process to deal with wider system integration lacking**

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Must Build HSI into Program Requirements

- **Design for Life Cycle Costs**
  - **Operability, Trainability & Maintainability must be built in as major drivers in acquisition requirements**
  - **Hold program manager accountable for full range of KPIs**
- **Requires**
  - **Integration into program development offices, Program Offices, & PEOs**
  - **Cadre of trained requirements writers**
  - **Well written requirements**
    - **Can be objectively evaluated**
    - **Detailed, clear**
    - **Use of rapid prototyping – testing**
  - **Requirement for meeting HRL milestones early in program**
  - **S&T to deliver detailed requirements for new technologies**

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Goal

- **Elevate HSI to provide a high level understanding of its status in a given program**
  - **Should put emphasis on HSI testing/development**
    - **Must be tied to concrete human-system effectiveness measures**
  - **Promote addressing HSI issues early in the development process**
    - **Provide awareness of resources needed earlier in the development process**
  - **Cross HSI disciplines (user interface, training, ….)**

Gaining Leverage on the Process

Is it ready?

What needs Attention?

Methodology, Metrics, Process, Design, Details

Big Picture Relevance

Details

Diagnostics

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Technology Readiness Level (TRL)

TRL 1 – Basic principles observed & reported
TRL 2 – Technology concept and/or application formulated
TRL 3 – Analytical & experimental critical function and/ characteristic proof of concept

Initial incorporation of principles and data to form system

TRL 4 – Component and/or breadboard validation in laboratory
TRL 5 – Component and/or breadboard validation in relevant environment
TRL 6 – System/subsystem model or prototype demonstration in relevant environment

Subsystem testing of increasing fidelity

TRL 7 – System prototype demonstration in operational environment
TRL 8 – Actual system completed and qualified through test and demonstration
TRL 9 – Actual system proven through successful mission operations

Full scale testing

Manufacturing Readiness Level (MRL)

MRL 1 – Basic manufacturing implications identified
MRL 2 – Manufacturing concepts identified
MRL 3 – Manufacturing proof of concept developed

Initial incorporation of principles and data to form system

MRL 4 – Capability to produce the concept in a laboratory
MRL 5 – Capability to produce prototype components in a production relevant environment
MRL 6 – Capability to produce a prototype system or subsystem in a production relevant environment.

Subsystem testing of increasing fidelity

MRL 7 – Capability to produce systems, subsystems or components in a production representative environment.
MRL 8 – Pilot line capability demonstrated. Ready to begin low rate production
MRL 9 – Low Rate Production demonstrated. Capability in place to begin Full Rate Production.
MRL 10 - Full Rate Production demonstrated and lean production practices in place

Full scale testing

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Human Readiness Level (HRL)

- **Technology Readiness Level**
  - **Accepted measure of technology maturity and readiness**
  - **Includes systematic experimentation, testing and refinement to show the technology as proven**
  - **Well understood in engineering community as requirement for moving system from design into operational use**
  - **Provides tracking throughout development (6.1-6.5)**
- **Human Readiness Level**
  - **Creates a measure of the readiness of the technology for use by human operators/maintainers**
- **Develop a Usable HRL Scale**
  - **Follows same understood paradigm of testing and refinement as TRL**
- **Goal is to make HRL as much of a requirement as TRL for moving a new system into operational use.**

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Human Readiness Level (DRAFT)

- **HRL 1 – Basic HF/E principles observed & reported**
- **HRL 2 – Basic HF/E principles & standards applied to system design**
- **HRL 3 – Prototype of user interface developed**

Initial incorporation of principles and data to form system

- **HRL 4 – User interface prototype validated in part-task simulation**
- **HRL 5 – User interface prototype validated in mission relevant simulation**
- **HRL 6 – User interface prototype modified to incorporat lessons learned to provide optimal human performance, workload, situation awareness, usability, reach, fit, trainability and safety**

Subsystem testing of increasing fidelity

- **HRL 7 – User interface prototype validated in operational environment**
- **HRL 8 – User interface of actual system complete and qualified across the operational envelope through operational testing**
- **HRL 9 – User interface successfully used in operations across the operational envelope**

Full scale testing

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Needs to include all aspects of HSI pertinent to system design

- **Human factors engineering**
  - **UI Design – physical, cognitive & perceptual**
    - **Principles & standards**
    - **Performance indicators – time, error, workload, situation awareness, fit, reach**
  - **Map to operational needs of users (function analysis, cognitive task analysis)**
  - **Suitability and ease of use in operational conditions, by representative manpower characteristics**
- **Safety**
  - **Error resistance, Error detection, Error recovery**
- **Training**
  - **Trainability**
- **Maintainability**
  - **HFE for the Maintainer**

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Summary

- **HSI needs to overcome significant challenges in its degree of instantiation in programs**
- **Key Leverage Points**
  - **HRL Levels – raise the visibility of HSI**
  - **Requirements**
    - **HSI must be in system requirements (operability, maintainability, trainability)**
  - **Support DYI systems development**
  - **Convert our metrics to the metrics the decision makers care about**
    - **Costs (ROI)**
    - **Mission Performance**

"If you keep doing what you have been doing, you will keep getting what you have been getting"

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